



US 20200110934A1

(19) **United States**

(12) **Patent Application Publication**
PAUL

(10) **Pub. No.: US 2020/0110934 A1**

(43) **Pub. Date: Apr. 9, 2020**

(54) **AUGMENTED REALITY SYSTEM FOR
ASSET TRACKING AND VISUALIZATION
USING INDOOR POSITIONING SYSTEM**

(52) **U.S. Cl.**
CPC *G06K 9/00671* (2013.01); *G01S 13/878*
(2013.01); *H04W 4/024* (2018.02); *H04W*
4/33 (2018.02)

(71) Applicant: **General Electric Company,**
Schenectady, NY (US)

(72) Inventor: **Ratnadeep PAUL,** Cohoes, NY (US)

(21) Appl. No.: **16/153,377**

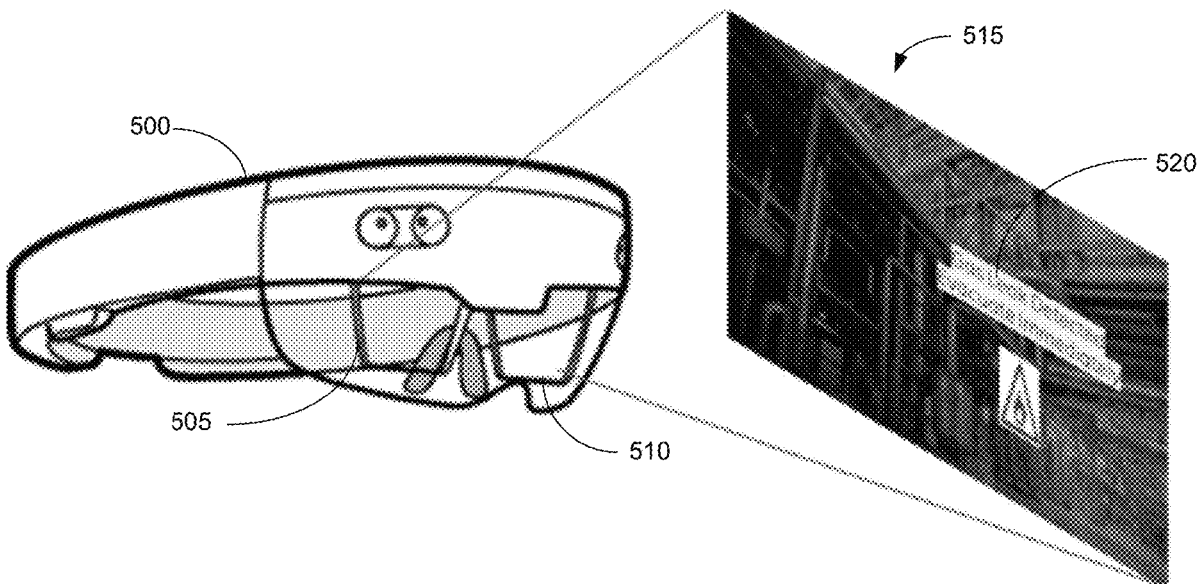
(22) Filed: **Oct. 5, 2018**

Publication Classification

(51) **Int. Cl.**
G06K 9/00 (2006.01)
H04W 4/33 (2006.01)
H04W 4/024 (2006.01)
G01S 13/87 (2006.01)

(57) **ABSTRACT**

A method and system to receive an indication of a location of an asset from a tag associated with and adjacent to the asset, the location of the asset being within a known mapping of an indoor environment; receive an indication of a location of an augmented reality device, the indicated location of the asset being within the known mapping of the indoor environment; determine a location of the asset relative to the augmented reality device based on the received information from the asset and the received information from the augmented device; determine contextual directions from the determined location of the augmented reality device to the indicated location of the asset; and present, in a current field of view display on the augmented reality device a combination of a representation of the determined location of the asset and a representation of the determined contextual directions.



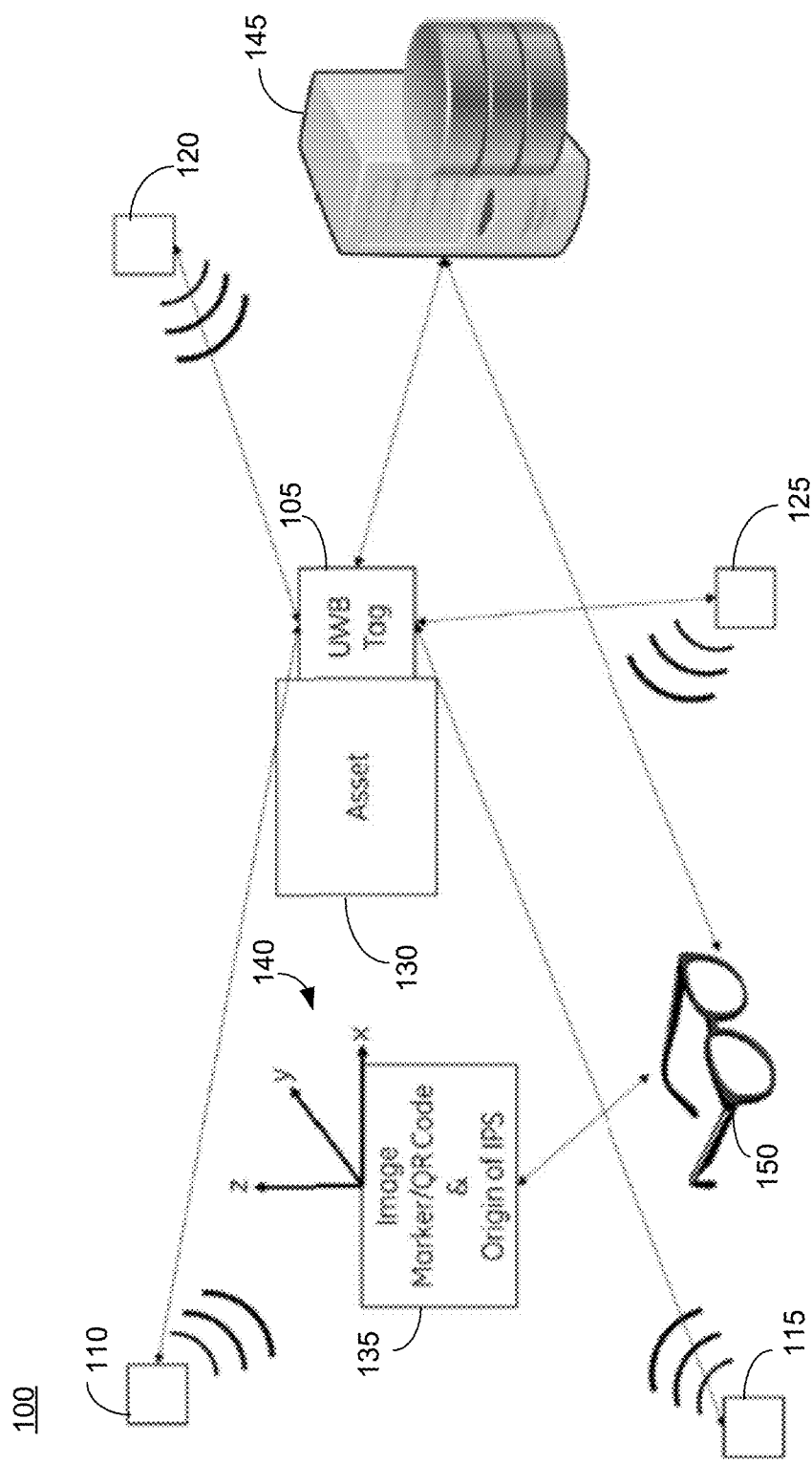


FIG. 1

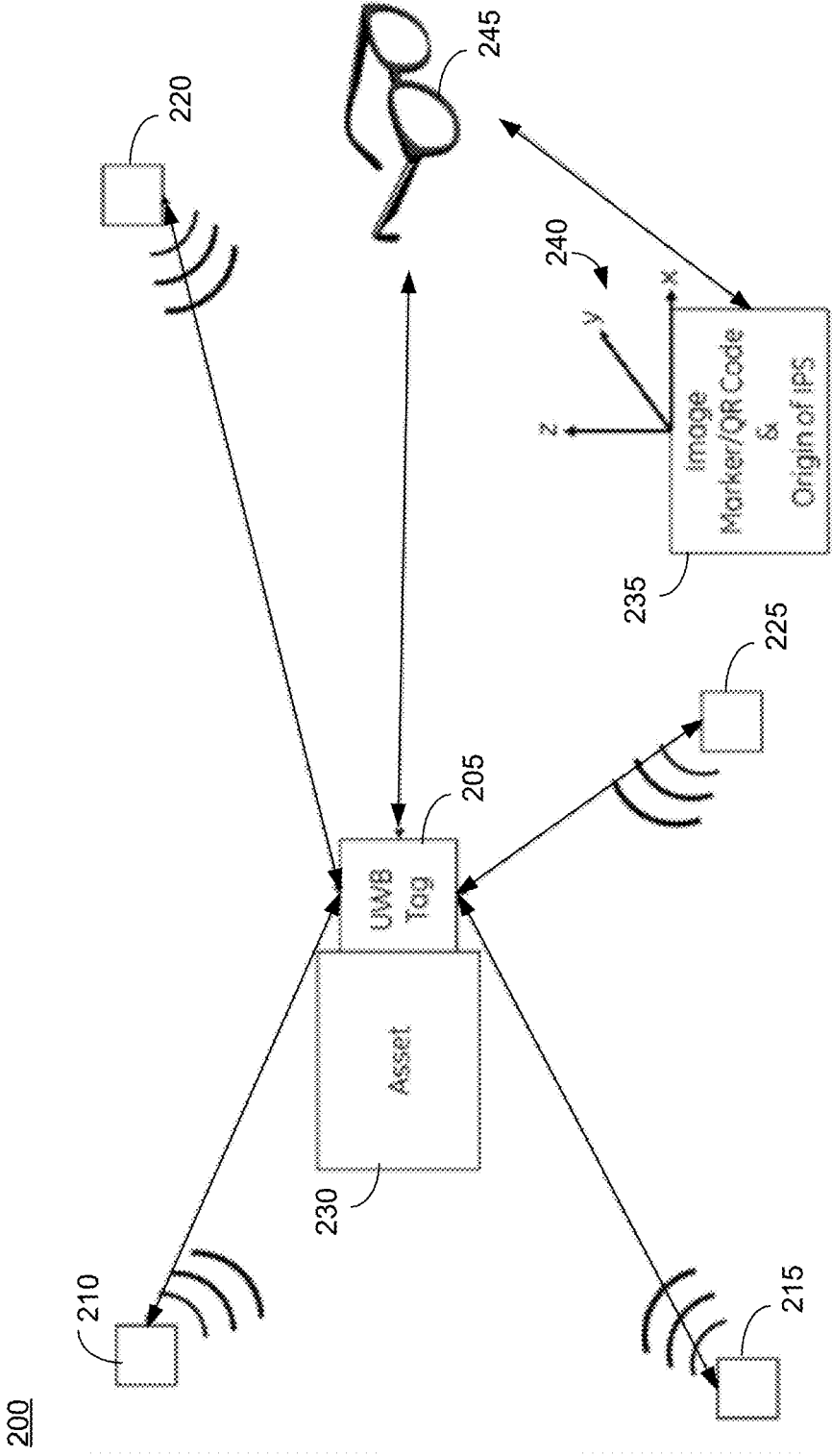


FIG. 2

300

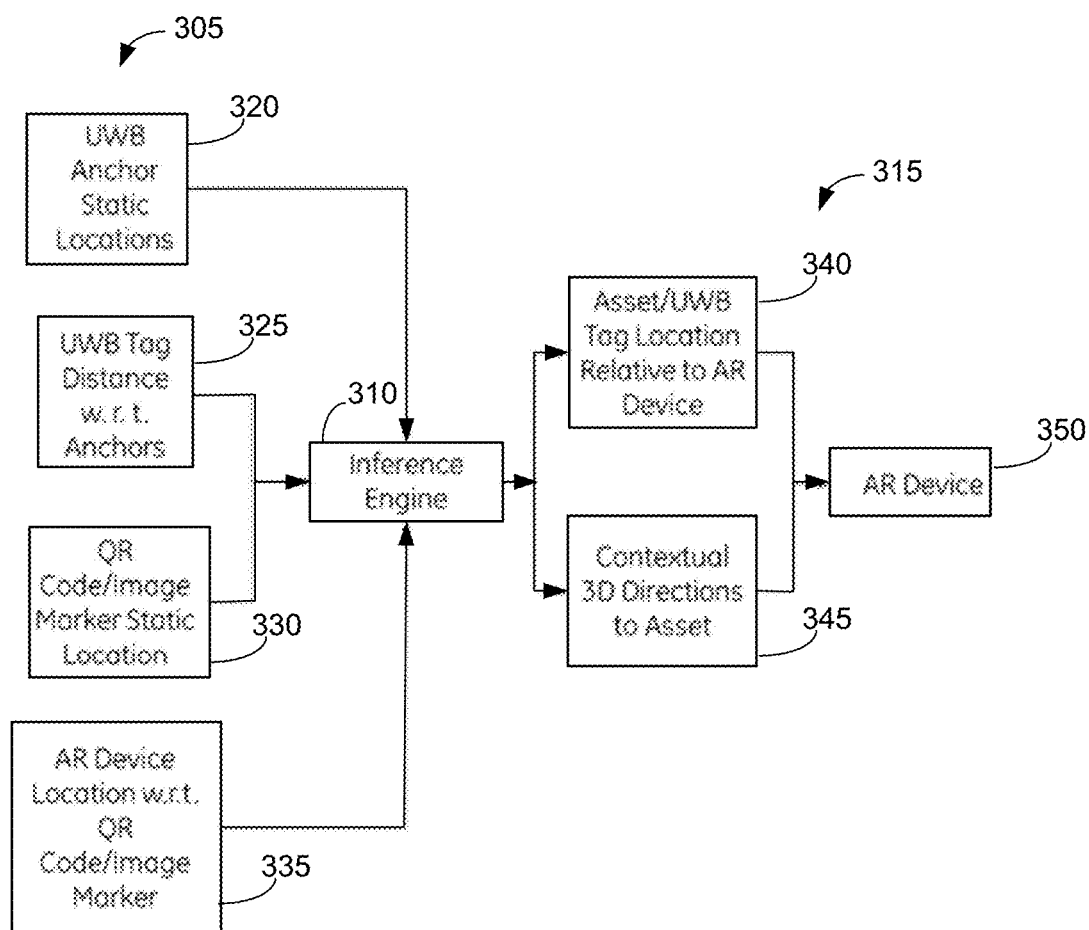
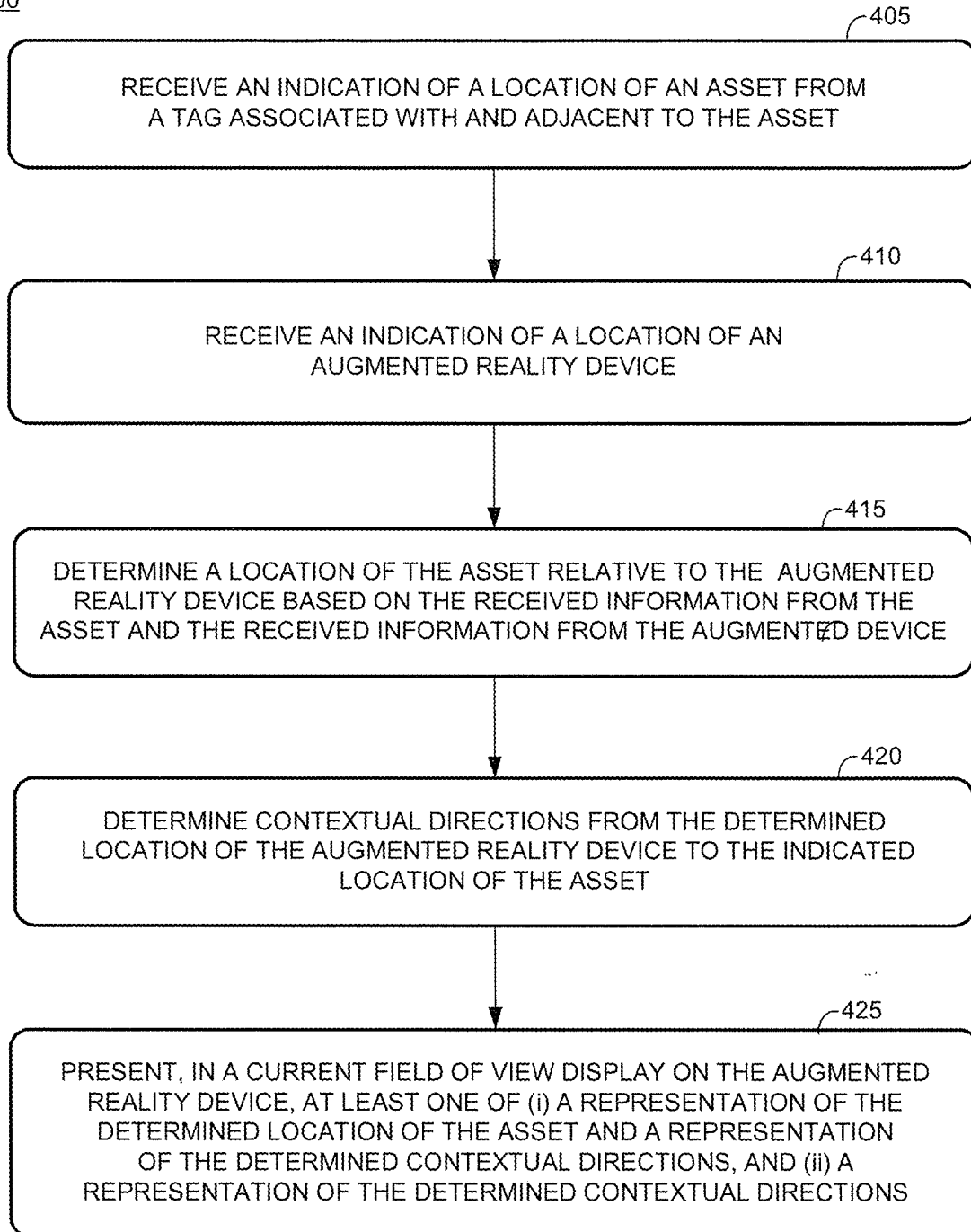


FIG. 3

400

**FIG. 4**

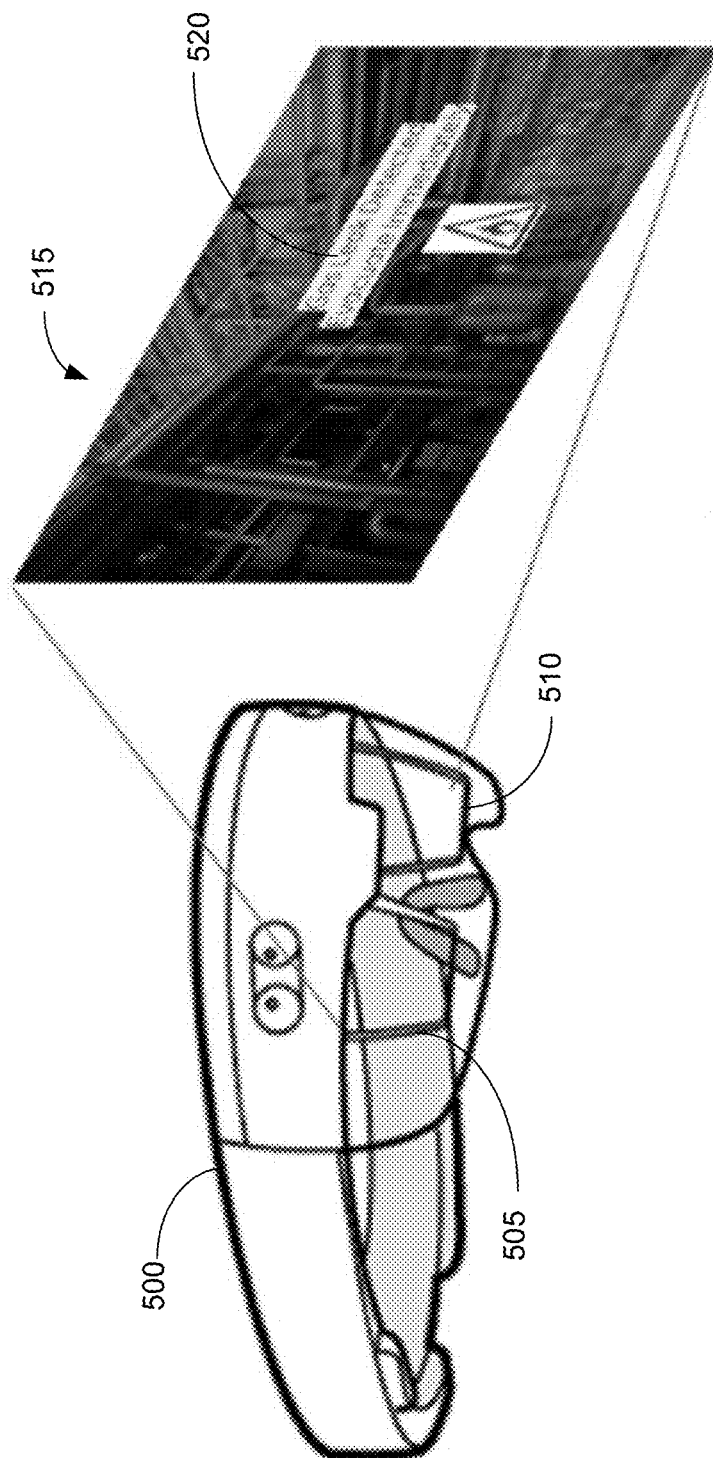


FIG. 5

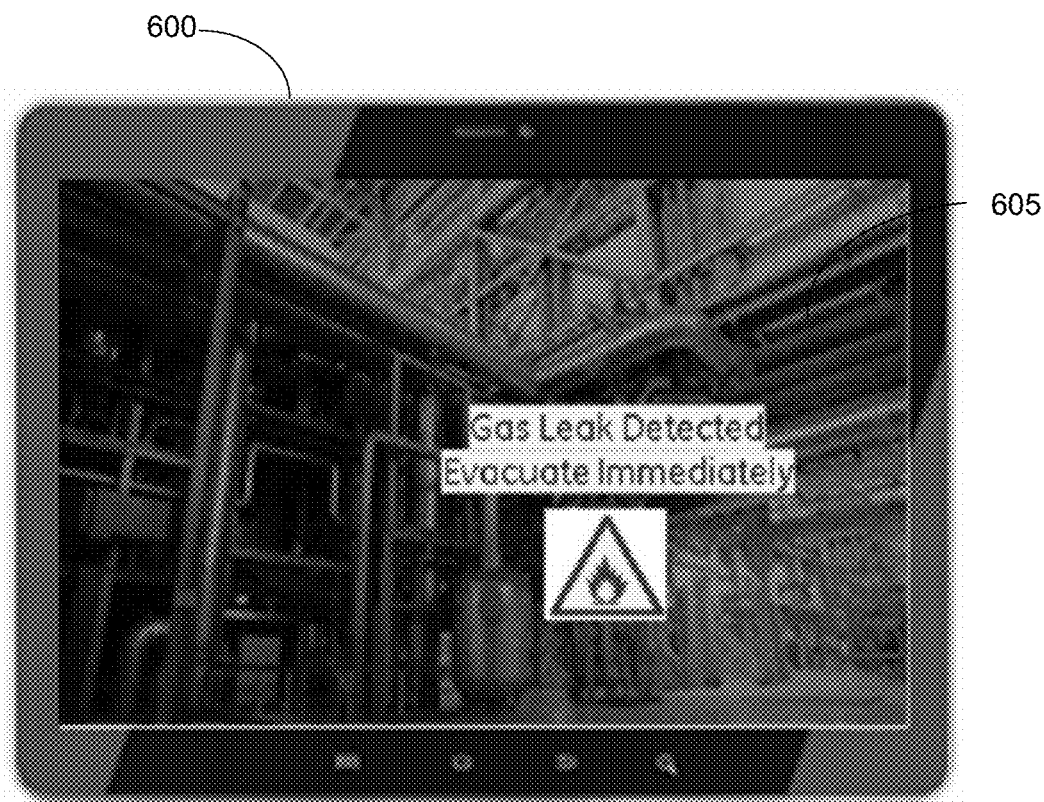


FIG. 6

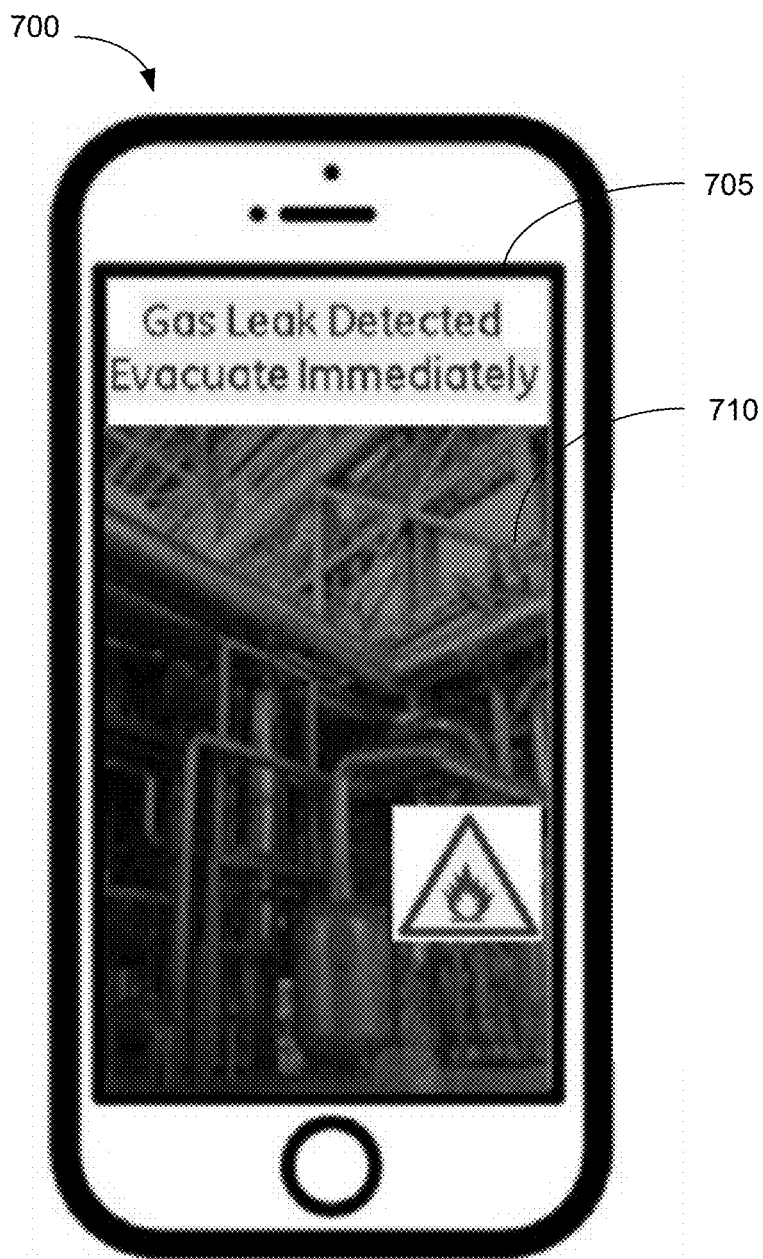


FIG. 7

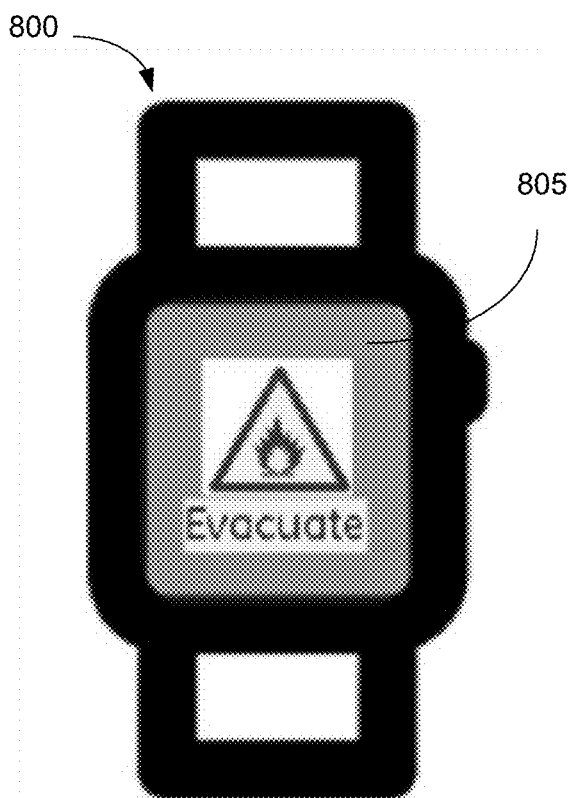


FIG. 8

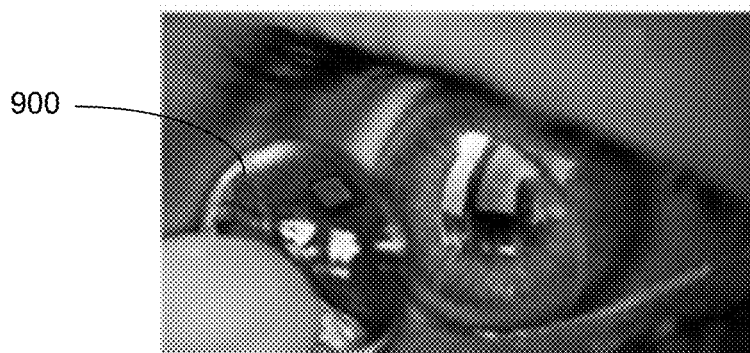


FIG. 9

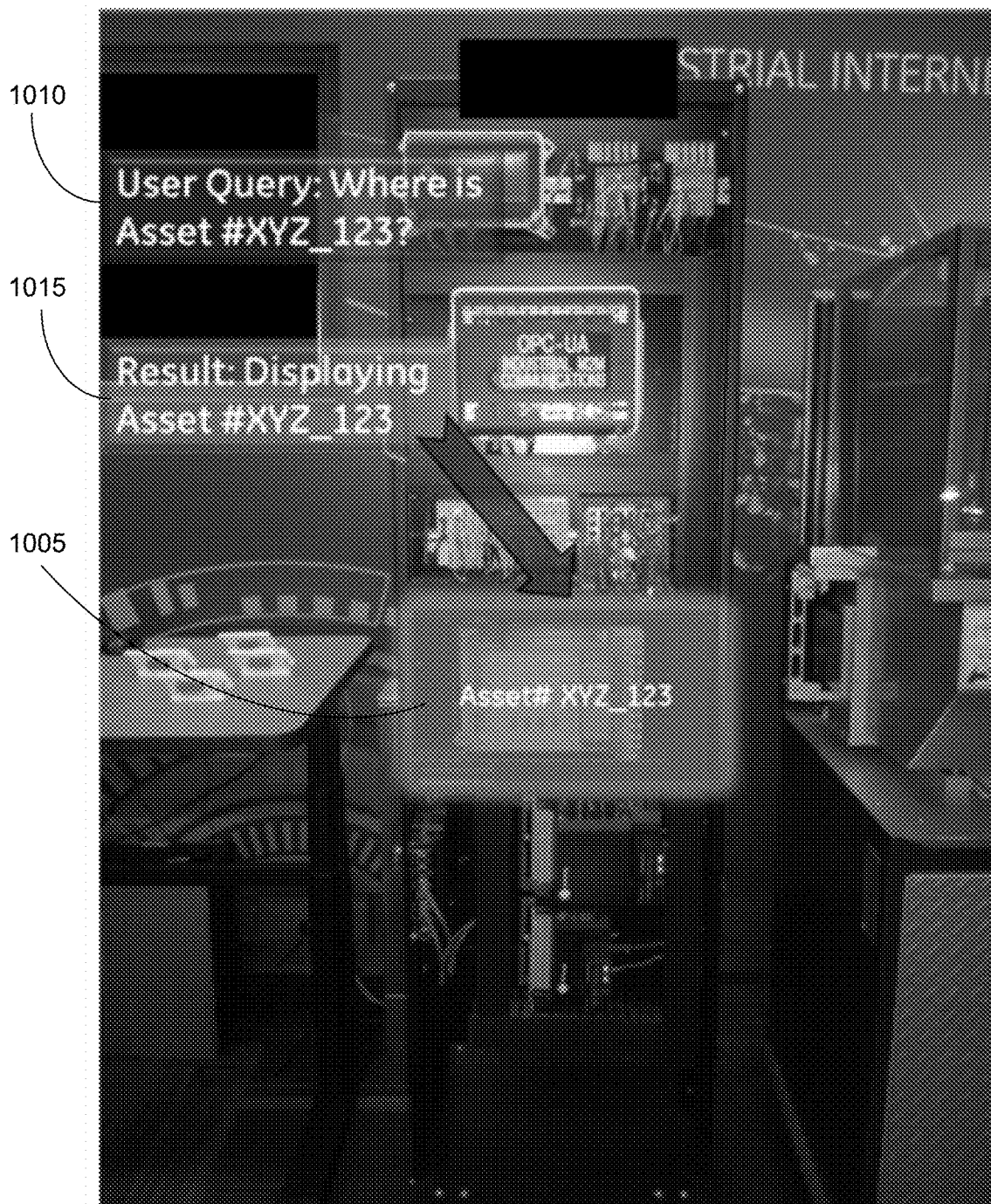


FIG. 10



FIG. 11

**FIG. 12**

1300

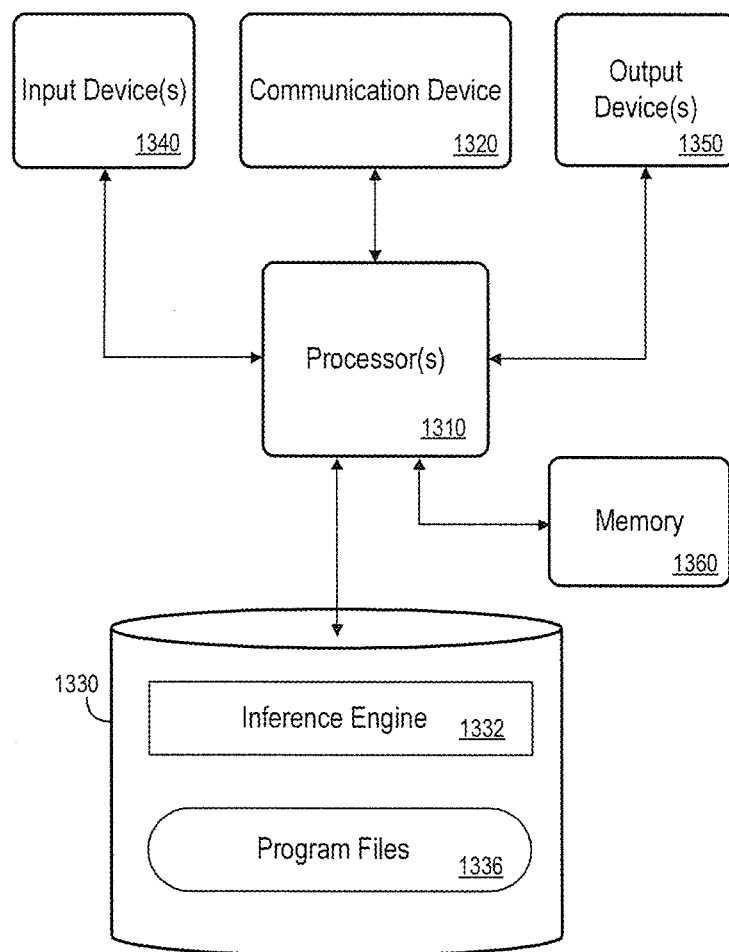


FIG. 13

AUGMENTED REALITY SYSTEM FOR ASSET TRACKING AND VISUALIZATION USING INDOOR POSITIONING SYSTEM

BACKGROUND

[0001] The field of the present disclosure relates generally to an augmented reality system, more particularly, to an augmented reality system integrated with a system that tracks assets.

[0002] A number of technological advances have been realized regarding the tracking of assets. In separate technical areas from the tracking of assets, many advances and improvements have been made in the areas of augmented reality (AR). Some of the advances in AR provide mechanisms for a user to partake in enhanced, immersive, and interactive experiences with their environment. A number of such experiences focus on entertainment aspects and outcomes.

[0003] In some respects, a need exists for methods and systems that provide an integration of AR systems and devices and asset tracking systems such that an efficient, reliable, and responsive platform including the benefits of both systems may be realized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 is an illustrative schematic depiction of an example system, in accordance with some embodiments;

[0005] FIG. 2 is an illustrative schematic depiction of an example system, in accordance with some embodiments;

[0006] FIG. 3 is an illustrative block diagram of an example system architecture or platform, in accordance with some embodiments;

[0007] FIG. 4 illustrates a flow diagram for an example process, in accordance with some embodiments;

[0008] FIG. 5 illustrates an example of augmented reality device system, in accordance with some embodiments;

[0009] FIG. 6 illustrates another example of augmented reality device system, in accordance with some embodiments;

[0010] FIG. 7 illustrates yet another example of augmented reality device system, in accordance with some embodiments;

[0011] FIG. 8 illustrates an example of augmented reality device system, in accordance with some embodiments;

[0012] FIG. 9 illustrates still another example of augmented reality device system, in accordance with some embodiments;

[0013] FIG. 10 illustrates an example of a field of view of an augmented reality device system including a display of an asset, in accordance with some embodiments;

[0014] FIG. 11 illustrates an example of a field of view of an augmented reality device system including a display of directions to an asset, in accordance with some embodiments;

[0015] FIG. 12 illustrates an example of field of view of an augmented reality device system including a display of directions to an asset not in the field of view, in accordance with some embodiments; and

[0016] FIG. 13 illustrates a schematic diagram of a system, in accordance with some embodiments.

DETAILED DESCRIPTION

[0017] Embodiment systems and methods herein relate to an Augmented Reality (AR) system that visualizes asset-related location data in combination with contextual directions relative to the asset and an AR device within a current field of view (FOV) of the AR device. In some embodiments, the AR device might display an indication of the contextual directions to direct a user to the location of the asset, particularly when the asset is not located in the current FOV of the AR device.

[0018] In some aspects, the present disclosure relates to an AR system integrated with an indoor positioning system (IPS) that supports and provides mechanisms to dynamically track assets within an environment covered by the IPS and to further visualize the assets in an AR device registered or otherwise associated with the AR system. In some aspects, the methods and systems of the present disclosure provide a visualization of the current, actual relative location of an asset tracked within an IPS in a current FOV of an AR device. In some instances and use-cases, a user of the AR device presented with a display of this combination of visualized information, may be made contextually aware of their current location relative to the tracked assets within their FOV and, in an instance the tracked assets are not within their FOV, be presented with contextual 3D directions from their current location to the tracked assets.

[0019] In some embodiments, a system disclosed herein may comprise an AR system and an IPS. Furthermore, the system may include an AR device including a display device/system that is registered to the AR system, an IPS based map of an environment of interest (e.g., a warehouse, factory, office building, or other area/facility covered by the IPS), a tracking system to locate assets within the IPS mapped environment, a system to track the AR device within the IPS mapped environment, a data management system (e.g., a server, a database, and combinations thereof) to store asset-related location information, and a communication network to facilitate and support communication between the IPS, the AR device, and the data management system.

[0020] FIG. 1 is an illustrative schematic depiction of an example system 100, in accordance with some embodiments. System 100 includes, in some aspects, an AR system and asset tracking system. In the example embodiment of FIG. 1, system 100 includes a plurality of location beacons 110, 115, 120, and 125. Each location beacon is at a known, fixed location. The location of each location beacon is known with respect to a predetermined coordinate system. The fixed locations may correspond to different infrastructure positions of an environment such as, for example, a wall, a pillar, a support, a door, and other fixtures. System 100 further includes a tag 105. Tag 105 is associated with an asset to be tracked within the environment of system 100. In some aspects, tag 105 is located adjacent to (e.g., physically proximal to, in or on) asset 130. In this manner, knowing a location and orientation of tag 105 equates to knowing the location and orientation of asset 130 itself. In some embodiments, system 100 may include multiple tags, with each tag being associated with and affixed adjacent to an asset and capable of communicating with the plurality of location beacons.

[0021] Communication between the plurality of location beacons 110, 115, 120, and 125 and tag 105 may be via a wireless communication protocol. In some embodiments, the communication technology protocol used by location

beacons **110**, **115**, **120**, and **125** and tag **105** may be an ultra-wide band (UWB) technology. In some instances, UWB herein refers to technologies that transmit information spread over a large bandwidth (e.g., >500 MHz). Specific characteristics of the UWB communication signals used by the devices disclosed herein may vary.

[0022] The location beacons and tag(s) of system **100** may form at least a portion of the IPS of system **100**. The plurality of location beacons **110**, **115**, **120**, and **125** (may include fewer or more location beacons but, in some systems, at least n , where $n > 3$) and tag(s) **105** may correspond to and encompass or cover an environment of interest, where each such environment can be fully mapped using the multiple location beacons and tags.

[0023] In some embodiments, each asset (e.g., **130**) has an associated tag (e.g., **105**) and the tag's three-dimensional location (x, y, z) and orientation (α , β , γ) are calculated using an UWB based radio communication system. In some aspects, UWB technology communication protocols are used herein to achieve centimeter level tracking accuracy that can be useful in tracking and locating assets in a multitude of different scenarios and applications, including but not limited to hospitals, warehouses, factories, power-plants, etc.

[0024] A location of a tag **105** in system **100** may be calculated based a determination of a distance between a particular tag and one or more of the location beacons in system **100**. The determined location of tag **105** may be transmitted via a UWB signal to server **145**. Data management system or server **145** may be implemented as a central server and/or database, a distributed server and/or database, and a cloud-based service.

[0025] An image marker **135** is physically included in system **100** at an origin of a coordinate system **140**. Image marker **135** may be a visual image configured according to a design specification to include information, where the information may be coded per the design specification to convey, for example, an orientation of the image marker, a location of the image marker, a reference to other information, and other data. Image marker **135** may be a barcode, a Quick Response (QR) code, and other machine-readable two-dimension labelling schemes. Image marker **135** has its own coordinate system, as illustrated at **140**. In some embodiments, coordinate system **140** includes a positive x-axis along a longer axis of the image marker, a positive y-axis along a shorter axis of the image marker, and a z-axis that is orthonormal to the plane of the image marker. In some aspects, the coordinate system of the IPS comprising the location beacons **110**, **115**, **120**, and **125** and tag(s) **105** is aligned with the coordinate system **140** of the image marker by virtue of the image marker being physically located or attached to the origin of the IPS coordinate system.

[0026] In some aspects, image marker **135** may be optically scanned by AR device **150**. In some embodiments, AR device **150** includes an image capture device/system (e.g., a camera) to optically scan image marker **135**. The AR system's coordinate system or universe may be aligned with the marker coordinate system **140** by scanning image marker **135** by AR device **150**.

[0027] In some respects, since the image marker coordinate system **140** is aligned with the IPS coordinate system by virtue of the image marker being positioned at the origin of the IPS' known coordinate system, the AR system's coordinate system is also aligned with the IPS' coordinate

system. That is, the AR system's and the IPS' coordinate systems may be aligned with each other when configured as disclosed herein. With both the AR system and the IPS being referenced to the same coordinate system, the locations of the tag(s) **105** calculated by the UWB IPS of system **100** may be aligned and coordinated with the AR system of system **100** that includes AR device **150**. Accordingly, the locations of tag(s) **105** and the asset(s) **130** associated with and affixed adjacent to the tag(s) herein may be accurately represented and included in a field of view of AR device **150**. In this manner, a consolidated FOV might be displayed by AR device **150** that includes the AR device's actual, current FOV and the assets (e.g., **130**) tracked in the environment of system **100** as they come into view within the current FOV.

[0028] In some aspects, server **145** may maintain and manage a searchable database including, for example, of all the tags of system **100**, as well as their associated assets and the locations of those assets where the location for each location may be continually updated. In some aspects, the database of server **145** may be queried (e.g., via a voice or text search submitted by a user of AR device **150**) for any asset's location maintained and updated in the database.

[0029] In some aspects, a tag **105** associated with an asset **130** herein may operate to communicate with the location beacons **110**, **115**, **120**, and **125** in its environment (e.g., hospital, warehouse, factory, school, etc.), calculate its own position based on its relative distances from the plurality of location beacons, and further communicate its position to a server (e.g., **145**) which can relay such information to the AR device **150** when the server is queried by the AR device.

[0030] In some aspects, after an asset's location is determined, the AR device's display presents visual cues overlaid on the display of an actual object(s) within the FOV of the user. In the instance the object is outside the FOV of the AR device/user, then the system may provide visual cues and/or directions from the AR device/user's current location to the location of the asset on the AR device (e.g., a visor, headset, helmet, glasses, etc.) guide the user to the asset.

[0031] In some embodiments, the determined location and orientation of the assets may be live streamed to one or more (i.e., multiple) AR device via a server that delivers the location and orientation information within the FOV of the user. In some respects, system **100** provides a mechanism and platform for a user of AR device **150** to query the current location of an asset using a combination of voice, text and gesture commands, as supported by AR device **150** and the search capabilities of server **145**. In some aspects, system **100** including integrated AR system aspects and asset system tracking features provides the technical benefits of, for example, quickly and accurately locating and tracking high cost and/or critical item assets. Such benefits provided by the technical systems and methods disclosed herein might contribute to fewer lost items, reductions in the cycle time to locate items, increased productivity and efficiency, and other advantages.

[0032] FIG. 2 is an illustrative schematic depiction of an example system **200**, in accordance with some embodiments. System **200** may be similar in many aspects to system **100** disclosed in FIG. 1. However, FIG. 2 departs from FIG. 1 since system **200** does not include a server **145**. Instead of a server **145** (e.g., a central server and/or database), an AR system including AR device **245** may perform the functions described above in connection with server **145**. That is, the functions disclosed in the description of FIG. 1 as being

performed by server **145** may instead be performed by AR device **245** in FIG. 2. In some aspects, AR device **245** may include the requisite processing, communication, and memory resources to implement the functions disclosed previously as being performed by server **145**. Given the detailed description above of server **145** and the functions performed thereby, a repeat of the same functions and descriptions is not included here but an understanding of the functionality of AR device **245** can be had by referring to the description of server **145**.

[0033] Further regarding system **200**, system **200** includes a plurality of beacon locations **210**, **215**, **220**, and **225** that function similar to location beacons **110**, **115**, **120**, and **125**; a location tag **205** that operates similar to tag **105**; an asset **230** similar to asset **130**; an image marker **235** similar to image marker **135**; and an image marker coordinate system **240** similar image marker coordinate system **140**. As such, system **200** operates and provides many of the same or similar functions and benefits as system **100**, except AR device **245** also performs the functions previously reserved for server **145** in system **100**.

[0034] In some aspects, system **100** provides some technical benefit(s) by having AR device **245** onboard the functionalities of server **145**, including, for example, a more compact system (fewer components) and not having to have a separate (e.g., central) storage facility to store asset-related location data. In this scenario, queries submitted by a user may be processed by AR device **245**. In some embodiments, system **100** may be used in an instance where multiple AR devices are deployed. However, system **200** might also be implemented in some instances with multiple AR device, wherein the AR devices might directly communicate with each other.

[0035] FIG. 3 is an illustrative schematic diagram **300** of an example AR system integrated with an IPS tracking assets, in accordance with some embodiments herein. In some aspects, system **300** includes a number of inputs **305** from one or more location beacons, tags, image marker(s), and AR devices that may be processed by a processor-based inference engine **310** to produce a number of outputs **315** that may be displayed on an AR device **350**. In one embodiment, system **300** produces or otherwise generates a consolidated FOV including a combination of visualizations of a location of an asset being tracked and contextual directions to the asset.

[0036] Referring to FIG. 3, system **300** receives multiple different inputs. In some embodiments, additional types of inputs might be received and processed by system **300**. Input **320** is received from one or more (UWB) location beacons, and includes information indicative of a location of the beacon's location. In some aspects, this location information can include 3D coordinate information for each beacon, where the beacons are each located at a fixed position. Since the position of each location beacon is fixed (i.e., static), input **320** may need to be received once for each beacon, so long as the position of the location beacon is not disturbed. In some embodiments, input **320** may be received periodically.

[0037] Input **325** includes (UWB) information indicative of a distance of a tag (e.g., **105**, **205**) relative to the one or more location beacons referenced in input **320**. The relative distance of each tag from multiple different location beacons can be used to accurately determine the location of the tag, and by association, an asset located coincident with a

particular tag. In some embodiments, input **325** may be continually (or at least periodically) updated so as to provide an accurate basis for the calculation of a current or real-time location for an asset associated with a tag herein.

[0038] Input **330** includes information indicative of a location of an image marker. Since the image marker is physically and statically located at the origin of an IPS as disclosed herein, input **330** may only need to be received once, so long as the position of the image marker is unchanged. In some embodiments, input **330** may be received periodically.

[0039] Input **335** includes information indicative of a location of an AR device in a system herein. The location of the AR device may be referenced to the image marker of input **330**, as discussed hereinabove. In some embodiments, input **335** may be continually (or at least periodically) updated so as to provide a current or real-time location for an AR device herein.

[0040] In some aspects, the inputs **320**, **325**, **330**, and **335** may be transmitted to inference engine **310**. In some embodiments, inference engine **310** might include artificial intelligence (AI) aspects, such as machine learning, artificial neural networks, statistical learning, and other techniques. In some aspects, inference engine **310** may use one or more predetermined rules, lookup tables, and other stored data references to process inputs **305** to produce outputs **315**. In some instances, inference engine **310** might use a combination of AI aspects and one or more other techniques in processing inputs **305**. Operationally, inference engine **310** processes inputs **305** to determine and generate outputs **315**. Outputs **315** might include the two outputs shown in FIG. 3, including, for example, an asset's/tag's location relative to an AR device **340** and contextual directions (e.g., 3D direction) from the AR device's, current location to the asset referenced in output **340**. In some embodiments, inference engine **310** may be implemented in a server (shown in FIG. 1) and implemented in an AR device (illustrated in FIG. 2 by the absence of a server and as disclosed hereinabove) configured to, for example, receive inputs **305** and generate outputs **315** that are transmitted or otherwise communicated to or produced by an AR device herein. The server or AR device may include a memory and a processor cooperatively operating to execute program instructions to process inputs **305** to produce outputs **315**.

[0041] In some embodiments, inference engine **310** (or the functions thereof) may be embodied in AR device **350**, where AR device **350** includes sufficient processing power and memory (if needed) to execute the functions disclosed herein as being performed by inference engine **310**. That is, in some embodiments, inference engine **310** may be integrated into or at least functionally be performed, at least in part, by AR device **350**.

[0042] In some embodiments, a combination of an asset's location and contextual directions from the AR device's current location to an asset may be included in a consolidated FOV of an AR device display. In some instances, the FOV may include both a representation of the asset's determined location and a representation of the contextual directions when the FOV includes a view of the asset's current location. In an instance the asset is not (yet) in the AR device's FOV, then the AR device's display of the FOV might include the contextual direction to the asset, without a representation of the asset since the asset is not (yet) in the FOV.

[0043] In some embodiments, inference engine 310 can be implemented by a remotely located central or distributed server system or integrated with the AR device 350. In some embodiments including a remotely located inference engine, the inputs from a location beacon and/or tag may be communicated wirelessly (e.g., UWB) to a central (or distributed) computing and database server. In this scenario, inference engine 310 calculates the outputs and sends the determined outputs to an AR device 350 where the determined outputs may be displayed in a current, contemporaneous consolidated field of vision (FOV) of the user with respect to the AR device. In an embodiment including an inference engine incorporated into an AR device, the inputs from location beacons and tags may be communicated wirelessly (e.g., UWB) to the AR device, where the AR device processes the location and other information with its known location. In this scenario, inference engine 310, as implemented in the AR device, calculates and displays the outputs in a current, contemporaneous consolidated FOV of the user with respect to the AR device.

[0044] FIG. 4 is a flow diagram of an example process 400, in some embodiments herein. Process 400 might relate to a system (e.g., 100, 200), platform, or architecture as illustrated in, for example, FIG. 3. At operation 405, information indicative of a location of an asset is received from a tag associated with and adjacent to the asset. Being adjacent to the asset, the information received at operation 405 may be interpreted as being indicative of the location of the asset itself.

[0045] At operation 410, an indication of a location of an AR device associated with or otherwise registered with a system to produce visualization(s) related to the tracked asset(s) as determined based on the tag locations referenced in operation 405 may be received. The location information might include 3D coordinate information with respect to the same coordinate system defining the location of the tag.

[0046] At operation 415, a location of the tracked asset is determined relative to the AR device, based on the asset location information and AR device location information received at operations 410 and 415, respectively.

[0047] Proceeding to operation 420, a determination of contextual directions from the determined location of the AR device to the indicated location of the tracked asset is performed. The contextual directions may be continually updated as a location of the AR device changes as a wearer or user of the AR device changes.

[0048] Continuing to operation 430, a consolidated current FOV display on the AR device is presented that includes, at least one of (i) a representation of the determined location of the asset and a representation of the determined contextual directions, and (ii) a representation of the determined contextual directions. In some aspects, the displayed FOV will include aspect (i) when the asset is within the AR device's FOV but the AR device (user) is not directly on or next to the asset. In some aspects, the displayed FOV will include aspect (ii) when the asset is not (yet) within the AR device's FOV.

[0049] FIGS. 5-9 each include example depictions of an AR device, in some different embodiments. For example, FIG. 5 includes an illustrative depiction of an AR device including a visor 500 to be worn about the head of a person/user. Visor 500 includes display lenses/screens 505 and 510 on(to) which visualizations may be projected and/or

generated to produce a binocular view visualization 515 that includes a FOV 520 of the user at a current location of the AR device 500.

[0050] As another example, FIG. 6 includes an illustrative depiction of an AR device embodying a portable/mobile tablet 600 that might be carried or otherwise transported by a person/user. Tablet 600 includes display on which visualizations may be presented, including a FOV 605 of the user at a current location of the AR device 600 as acquired by one or more cameras on tablet 600 (not shown in FIG. 6).

[0051] FIG. 7 includes an illustrative depiction of an AR device including a mobile phone 700 that may be carried by a person or user of the mobile phone. Phone 700 includes a display screen 705 in which visualizations may be presented. The screen depicted in FIG. 7 includes a FOV 710 generated based on images and/or video acquired by one or more cameras (not shown in FIG. 7) of the mobile phone at a current location of the phone.

[0052] FIG. 8 includes an illustrative example depiction of an AR device including a "smartwatch" 800 that may be worn by a person or user thereof. Smartwatch 800 includes a display screen 805 in which visualizations may be presented. In some regards, aspects of the visualizations in FIG. 8 may be automatically adjusted based on the size of display screen 805, as compared to other AR device screens. Such adjustments might include a level of detail included in a visualization and/or the manner in which a visualization is effectuated (e.g., static display versus a scrolling display, etc.).

[0053] FIG. 9 includes an illustrative depiction of an implant-type of AR device, where the example of FIG. 9 is a contact lens that can selectively display visualizations to a wearer thereof. In some embodiments, the visualizations presented in/on contact lens 900 may include one or more of the visualization types disclosed herein.

[0054] FIG. 10 is an illustrative example of a FOV 1000 presented on an AR device system in the possession of a user, in accordance with some embodiments. FOV 1000 includes a visualization of the room in which the user wearing the AR device is located. FOV 1000 includes a graphical representation 1005 indicating a location of an asset (e.g., "Asset# XYZ_123"). This is a type of display that might be presented to a user on an AR device when the asset is within the AR device's FOV. Also shown is a query 1010 submitted by the user and the result 1015 resulting from an execution of that query.

[0055] FIG. 11 illustrates an example of a FOV 1100 presented on an AR device in the possession of a user, in accordance with some embodiments. FOV 1100 includes a visualization of the room in which the user wearing the AR device is located. FOV 1100 includes a graphical representation 1105 indicating a direction the user should travel in order to reach the location of the asset of interest (e.g., "Asset# XYZ_123"). As shown, the directions 1105 include contextual information to inform the user where the asset is in relation to their current FOV (e.g., "behind you"). This is a type of display that might be presented to a user on an AR device when the asset is not within the AR device's FOV but is in the same room as the user. Also shown is a query 1110 submitted by the user and the result 1115 for that query.

[0056] FIG. 12 is an illustrative example of a FOV 1200 presented on an AR device system in the possession of a user, in accordance with some embodiments. FOV 1200 includes a visualization of the room in which the user

wearing the AR device is located. FOV **1200** includes a graphical representation **1205** indicating directions to a location of an asset (e.g., “Asset# XYZ_123”). This is a type of display that might be presented to a user on an AR device when the asset is neither within the AR device’s FOV nor in the same room as the user/AR device. Also shown is a query **1210** submitted by the user and the result **1215** for that query.

[0057] FIG. 13 is a block diagram of computing system **1300** according to some embodiments. System **1300** may comprise a general-purpose or special-purpose computing apparatus and may execute program code to perform any of the methods, operations, and functions described herein. System **1300** may comprise an implementation of one or more systems (e.g., system **300**, an AR device, etc.) and processes (e.g., **400**). System **1300** may include other elements that are not shown, according to some embodiments.

[0058] System **1300** includes processor(s) **1310** operatively coupled to communication device **1320**, data storage device **1330**, one or more input devices **1340**, one or more output devices **1350**, and memory **1360**. Communication device **1320** may facilitate communication with external devices, such as a data server and other data sources. Input device(s) **1340** may comprise, for example, a keyboard, a keypad, a mouse or other pointing device, a microphone, knob or a switch, an infrared (IR) port, a docking station, and/or a touch screen. Input device(s) **1340** may be used, for example, to enter information into system **1300**. Output device(s) **1350** may comprise, for example, a display (e.g., a display screen) a speaker, and/or a printer.

[0059] Data storage device **1330** may comprise any appropriate persistent storage device, including combinations of magnetic storage devices (e.g., magnetic tape, hard disk drives and flash memory), optical storage devices, Read Only Memory (ROM) devices, etc., while memory **1360** may comprise Random Access Memory (RAM), Storage Class Memory (SCM) or any other fast-access memory.

[0060] Inference engine **1332** may comprise program code executed by processor(s) **1310** (and within the execution engine) to cause system **1300** to perform any one or more of the processes described herein. Embodiments are not limited to execution by a single apparatus. Data storage device **1330** may also store data and other program code **1336** for providing additional functionality and/or which are necessary for operation of system **1300**, such as device drivers, operating system files, etc.

[0061] In accordance with some embodiments, a computer program application stored in non-volatile memory or computer-readable medium (e.g., register memory, processor cache, RAM, ROM, hard drive, flash memory, CD ROM, magnetic media, etc.) may include code or executable instructions that when executed may instruct and/or cause a controller or processor to perform methods disclosed herein, such as a method of processing multivariable sensor data, sensor location, and AR device location to generate AR device visualization related to same (i.e., process **400**, FIG. 4).

[0062] The computer-readable medium may be a non-transitory computer-readable media including all forms and types of memory and all computer-readable media except for a transitory, propagating signal. In one implementation, the non-volatile memory or computer-readable medium may be external memory.

[0063] Although specific hardware and methods have been described herein, note that any number of other configurations may be provided in accordance with embodiments of the invention. Thus, while there have been shown, described, and pointed out fundamental novel features of the invention, it will be understood that various omissions, substitutions, and changes in the form and details of the illustrated embodiments, and in their operation, may be made by those skilled in the art without departing from the spirit and scope of the invention. Substitutions of elements from one embodiment to another are also fully intended and contemplated. The invention is defined solely with regard to the claims appended hereto, and equivalents of the recitations therein.

1. A method comprising:

receiving, by a processor, an indication of a location of an asset from a tag associated with and adjacent to the asset, the indicated location of the asset being within a known mapping of an indoor environment;

receiving, by the processor, an indication of a location of an augmented reality device, the indicated location of the augmented reality device being within the known mapping of the indoor environment;

determining, by the processor, a location of the asset relative to the augmented reality device based on the received information from the asset and the received information from the augmented device;

determining, by the processor, contextual directions from the determined location of the augmented reality device to the indicated location of the asset; and

presenting, in a current field of view display on the augmented reality device, at least one of (i) a representation of the determined location of the asset and a representation of the determined contextual directions, and (ii) a representation of the determined contextual directions.

2. The method of claim 1, wherein the known mapping of the indoor environment is determined based on:

location information received from a plurality of location beacons, each of the location beacons being positioned at a fixed location relative to a known coordinate system within the indoor environment; and

location information received from the asset including a distance of the asset’s location from the plurality of location beacons within the indoor environment.

3. The method of claim 1, wherein the plurality of location beacons transmit their location and communicate with the tag associated with the asset via an ultra-wideband communication technology protocol.

4. The method of claim 1, wherein the indication of the location of the asset further includes an orientation of the asset.

5. The method of claim 1, wherein the indication of the location of the augmented reality device further comprises an orientation of the augmented reality device.

6. The method of claim 1, wherein the presenting includes, in an instance the asset is located in the current field of view, the representation of the determined location of the asset.

7. The method of claim 1, wherein the presenting includes, in an instance the asset is not located in the current field of view, the representation of the determined location of the asset and the representation of the determined contextual directions.

8. The method of claim 1, wherein the visualization of the determined contextual directions includes at least one of:

- a directional arrow,
- a color-coded indication of a route or direction to travel, and
- a textual description of a route to the determined location of the asset.

9. The method of claim 1, wherein the augmented reality device is one of a headset with a display, visor having a display, an eyewear device having a display, a portable computing device with a display, a wearable device with a display, a device in or on a person, and a mobile phone device with a display device.

10. The method of claim 1, wherein the augmented reality device is collocated with one of a person and an unmanned mobile device.

11. A system comprising:

- a memory storing processor-executable instructions; and
- a processor to execute the processor-executable instructions to cause the system to:

- receive an indication of a location of an asset from a tag associated with and adjacent to the asset, the indicated location of the asset being within a known mapping of an indoor environment;

- receive an indication of a location of an augmented reality device, the indicated location of the augmented reality device being within the known mapping of the indoor environment;

- determine a location of the asset relative to the augmented reality device based on the received information from the asset and the received information from the augmented device;

- determine contextual directions from the determined location of the augmented reality device to the indicated location of the asset; and

- present, in a current field of view display on the augmented reality device, at least one of (i) a representation of the determined location of the asset and a representation of the determined contextual directions, and (ii) a representation of the determined contextual directions.

12. The system of claim 11, wherein the known mapping of the indoor environment is determined based on:

location information received from a plurality of location beacons, each of the location beacons being positioned at a fixed location relative to a known coordinate system within the indoor environment; and

location information received from the asset including a distance of the asset's location from the plurality of location beacons within the indoor environment.

13. The system of claim 11, wherein the plurality of location beacons transmit their location and communicate with the tag associated with the asset via an ultra-wideband communication technology protocol.

14. The system of claim 11, wherein the indication of the location of the asset further includes an orientation of the asset.

15. The system of claim 11, wherein the indication of the location of the augmented reality device further comprises an orientation of the augmented reality device.

16. The system of claim 11, wherein the presenting includes, in an instance the asset is located in the current field of view, the representation of the determined location of the asset.

17. The system of claim 11, wherein the presenting includes, in an instance the asset is not located in the current field of view, the representation of the determined location of the asset and the representation of the determined contextual directions.

18. The system of claim 11, wherein the visualization of the determined contextual directions includes at least one of a directional arrow, a color-coded indication of a route or direction to travel, and a textual description of a route to the determined location of the asset.

19. The system of claim 11, wherein the augmented reality device is one of a headset with a display, visor having a display, an eyewear device having a display, a portable computing device with a display, a wearable device with a display, a device in or on a person, and a mobile phone device with a display device.

20. The system of claim 11, wherein the augmented reality device is collocated with one of a person and an unmanned mobile device.

* * * * *